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When Something Is at Stake: Differences in Soccer Performance in 11 vs. 11 During Official Matches and Training Games

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Abstract

Olthof, SBH, Frencken, WGP, and Lemmink, KAPM. When something is at stake: Differences in soccer performance in 11 vs. 11 during official matches and training games. *J Strength Cond Res* 33(1): 167–173, 2019–11 vs. 11 training games are used to mimic the official match, but differ in playing duration and a consequence of winning or losing. Anxiety levels, crowd pressure, and the intention to win are examples of constraints present in the match, but absent or less prevalent in training. The aim is, therefore, to compare soccer performance in official matches with 11 vs. 11 training games. Six elite youth soccer teams played 5 official matches and 15 training games. Soccer performance, defined as a combination of game characteristics (game duration, transitions, and ball possession duration) and physical (distance covered, high-intensity distance, and sprints), technical (passing), and team tactical performance (inter-team and intra-team distances) and corresponding interaction patterns, was determined with video footage and positional data (local position measurement system). Soccer performance in official matches differed from similar training games, in a way that players covered more distance, sprinted more often, but game pace was lower and players made more mistakes. In addition, team width was smaller and length-per-width ratio larger and teams were tighter coupled in official matches. 11 vs. 11 training games can be used to mimic the match, in particular the team tactical performance. Coaches could increase physical and technical representativeness of training games by raising the stakes and increasing the consequence of winning or losing.

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Introduction

Two teams of 11 players, pitch size, and official playing rules shape the performance of players in an official soccer match (21). Soccer performance in the match is typically quantified in physical, technical, and team tactical performance measures. In particular, high-intensity activities, various on-ball actions (such as passing), and inter-team and intra-team measures have been subject to research to investigate elite soccer performance (1,25,27). These performance measures give insight into the movement activities and coordination patterns of players and teams, which is helpful to quantify the match load and subsequently design training sessions. However, this information is still fragmented into subdisciplines of sport science, rather than that they provide a holistic view of soccer performance (7,20).

Training games during soccer practice are designed to simulate (situations from) the match and combine the physical, technical, and tactical skills in an exercise (23). In particular, the 11 vs. 11 training game is intended to closely mimic the match with similar playing rules, number of players, pitch size, and playing rules. Therefore, this training game meets the requirements of a representative learning design as suggested by Araújo and Davids (4) and Davids et al. (11), which would optimally enable a positive transfer of skills from training to performance environment (i.e., the official match). From the expert opinion of soccer trainers, 11 vs. 11 is regularly played in training sessions for an optimal tactical match preparation, rather than e.g., a physical training stimulus. This is strengthened by Djaoui et al. (12), who revealed higher peak sprinting speeds in the official match than in an 11 vs. 11 training game. Although match and training contexts look alike, these findings suggest that there may be differences in constraints underlying these differences in performance outcomes.

In daily practice, soccer trainers often compromise in playing duration and choose to play training games with shorter duration and multiple bouts to control the physical

stimulus (2). It rarely happens that the 11 vs. 11 game is played for 90 minutes. Logically, this compromise stresses the physical capacities of the players differently in relation to the match. Moreover, a training game differs from the official match in attention of a crowd, a relative unknown opponent, and the pressure to win. These constraints can be categorized into environment and players, which consequently shape behavior (19,28). From the consequence of winning or losing, a specific set of constraints evolves and this characterizes a high pressure in a match where "something is at stake" (32). However, to enhance learning, this pressure is often removed from training (22,32). Hypothetically, this different set of constraints influences physical, technical, and team tactical performance (19,28). However, both the effects of differences in task duration and match constraints have been understudied in previous research.

Altogether, this study aims to compare performance in the official match with an 11 vs. 11 training game and provide a holistic view of soccer performance. Physical and technical performance measures reflect individual performance of players, whereas team tactical performance measures reflect collective behavior, such as team's dispersion on the pitch and coordination patterns. Based on the principles of the representative learning design, 11 vs. 11 training games should closely simulate the official match conditions, but the soccer performance might be different because of different set of constraints. For daily practice, this research will provide insight to soccer trainers how an 11 vs. 11 training game relates to the actual match demands.

Methods

Experimental Approach to the Problem

Six teams representing 3 professional youth academies played official matches and 11 vs. 11 training games to evaluate soccer performance during competition and practice. A cross-sectional design is used to test the differences in typical physical, technical, and team tactical performance measures and corresponding interaction patterns (1,6,14,18) between official matches and training games. Data were collected with the Local Position Measurement (LPM) system and video footage during the 2015–2016 Dutch competitive season. An integration of the performance measures provides a holistic view of the soccer performance during match and practice.

Subjects

Six teams of 3 Dutch youth academies of professional soccer teams participated in this study. These teams were assigned to 2 age groups, under-17 (mean ± *SD*: $n = 70$ players; 16.1 ± 1.38 years; range 14.9–17.1 years) and under-19 (mean ± *SD*: $n = 73$ players; 18.1 ± 1.16 years; range 16.6–25.8 years), and played official matches and 11-a-side training games. All players were informed about the purpose of the study and each player (and parents/legal guardians if the subject was younger than 18 years old) provided written informed consent. All procedures were approved by the local ethical committee of the Center for Human Movement Sciences of the Medical Faculty of the University Medical Center Groningen, University of Groningen, Groningen, the Netherlands.

Procedures

Each official match was played according to the official playing rules and duration. For the duration, this implies that under-19 played 2 × 45 minutes and under-17 2 × 40 minutes. In total, 5 official matches were played: 2 in the under-19 age group and 3 in the under-17 age group. There was one external opponent in the under-17 match, and the other matches were between the participating youth academies. All official matches were played as part of the under-17 and under-19 competition at national level.

Per team, three 11-a-side games were played in the training session. Each game was played for 10 minutes with a 4-minute rest period in between the games to ensure optimal recovery for the subsequent game (24). The 11-a-side games were preceded by a warm-up containing exercises with and without the ball. In total, 6 training games were played in the under-17 age group and 9 training games in the under-19 age group. Official playing rules were applied in these games. Coaches were instructed to coach in an activating and encouraging style, just like they would do in a competitive match (33). In-game substitutions only took place in case of an injury.

Team formation was similar in the official matches and the 11-a-side games. All teams played in a 1-4-3-3 formation and teams were allowed to play according to their club's playing style in both match and training game. Each match and game was played on an artificial turf pitch with pitch dimensions of 105 × 68 m.

Data Collection. During the official matches and 11-a-side games, positional data was collected from each player with the LPM system (Inmotio Object Tracking BV, Amsterdam, the Netherlands). Each player wore an LPM vest to collect individual x- and y-coordinates. This data collection took place with a sampling frequency that ranged 34–45 Hz, depending on the total number of players (starting formation and substitutes) assigned in the data collection (16,30).

In addition, video footage was recorded with 1 or 2 HD dome cameras (Bosch GmbH, Stuttgart, Germany) and 1 or 2 high-resolution digital cameras (available from university and youth academies) to ensure that all 22 players on the pitch were visible. Videos were automatically synchronized with the positional data in the Inmotio software.

Data Analysis. Calculations were performed in the data analysis using customized Matlab routines (Matlab R2015b; The Mathworks, Inc., Natick, MA, USA).

Game Characteristics. Total game duration was the duration between start and end of each match and game, any injury time included. Stoppages of play were excluded (3,34) and the remaining time was considered as effective playing time.

The ball was out of play or the game was stopped for an injury, substitution, or after a goal was scored. The game resumed after set pieces (throw in, corner kick, goalkeeper kick, free kick, or kick-off) when the player involved was ready and had the intention to resume the game. Relative playing time was calculated as the percentage effective playing time of the total game duration.

Ball possession of each team was analyzed with video analysis. Ball possession duration was determined when a team was in control of the ball until the moment the ball was out of play or the opponent won ball possession by an interception or duel (3,9). A transition was defined as a change in ball possession from one team to the other. Transitions were expressed as the number of transitions per minute of effective playing time to normalize for the difference in total game duration and effective playing time.

Physical Performance. Total distance covered, high-intensity distance (HID), and number of sprints were calculated with the positional data. Because the match and training games had different durations and effective playing times, physical performance variables were determined for the effective playing time. Total distance covered was expressed as meters per minute, HID as the percentage of the total distance covered by a player above 19.8 $km \cdot h^{-1}$, and the number of sprints as the frequency $\geq$25.2 $km \cdot h^{-1}$ per minute (1).

Technical Performance. Each pass was counted and evaluated on direction and success with notational analysis. Total number of passes of the team was corrected for the effective playing time and represented the pace of the game. The number of incorrect passes and forward passes was expressed as the percentage of total passes.

Team Tactical Performance. Positional data were used to calculate several team tactical performance measures for each sample of time. The team centroid is the average position of each outfield player on the pitch (15). Distance between team centroids in the longitudinal (X) direction is the inter-team distance (18). The average longitudinal and lateral (Y) distance of each player to this team centroid are the longitudinal and lateral stretch index, respectively (6). The maximal distance between players in the longitudinal and lateral direction is used to calculate the length and width of the team, respectively. The ratio between length and width is the length-per-width (LPW) ratio (14). The surface area of each team was calculated as the area of the convex hull (17). All team tactical performance measures were calculated for the effective playing time.

Running correlations of team centroids and dispersion measures of opposing teams were calculated over a 3-second moving window to determine coordination patterns of the effective playing time (10,18). Coordination patterns were considered as in-phase ($1 \leq r < 0.5$), no interaction ($0.5 \leq r \leq -0.5$), or anti-phase ($-0.5 < r \leq -1$).

Statistical Analyses

A customized *R* routine is used to conduct statistical analyses (*R* for Windows 324; R Foundation for Statistical Computing, Vienna, Austria). Data were checked on quality and normality. Five players were excluded in one under-19 match because their sampling frequency fluctuated during data collection. Therefore, their physical performance and the tactical performance measures of the corresponding team were left out of the analysis. Furthermore, visual inspection of boxplots of physical performance revealed that another 5 players were outside the interquartile range and were therefore considered as outliers. Their data were removed from further analysis.

Mean values and *SD*s were calculated for game characteristics, physical performance, technical performance, team tactical performance, and corresponding interaction patterns. Multivariate analyses of variance (MANOVAs) (Pillai's trace) were calculated to test for differences in game characteristics, as well as physical, technical, and team tactical performance between the official match and training game. Univariate analyses of variance were conducted when a main effect was detected. Significance level was set at 5%. Eta-squared (η^2) values were calculated and used to determine the effect size (26). Magnitude of these effects were considered as small ($\eta^2 < 0.06$), moderate ($0.06 \leq \eta^2 < 0.15$), or large ($\eta^2 \geq 0.15$) (8). Confidence intervals (CIs) of 95% were provided for differences between match and training game.

Results

Results from the MANOVAs revealed significant differences between the official match and training game for game characteristics ($F = 20.27$; $p < 0.001$), physical performance ($F = 90.05$; $p < 0.001$), technical performance ($F = 6.88$; $p < 0.05$), and team tactical performance ($F = 11.53$; $p < 0.001$). In the official match, there was significantly less relative playing time than in the training games, and duration of ball possession was reduced (Table 1). This resulted in a significantly higher rate of transitions of ball possession in the match than in the training. Effect sizes for all game characteristics were large.

Physical, technical, and team tactical performance measures differed between the official match and training. Players covered significantly more distance ($F = 237.1$; $p < 0.001$; $\eta^2 = 0.33$; CI -28.9 to -22.1) and sprinted more often ($F = 6.3$; $p < 0.05$; $\eta^2 = 0.01$; CI -0.1 to 0.0) in the match than in the training, but differences in HID were not significant ($F = 0.0$; $p = 0.9$; $\eta^2 = 0.01$; CI -0.4 to 0.6) and the magnitude of the effect for sprints per minute was small (Figure 1). Game pace was significantly lower in the official match with a large effect size ($F = 14.4$; $p < 0.001$; $\eta^2 = 0.36$; CI 1.1 to 3.7), expressed as a lower number of passes per minute. On average, there was a higher error percentage of passes in the official match than in the training game, but this effect was small ($F = 5.3$; $p < 0.05$; $\eta^2 = 0.02$; CI -11.0 to -0.6;

Table 1. Mean and *SD* and test statistics with the *F*-value, *p*-value, effect size (η^2), and 95% confidence interval (CI) of game characteristics, team tactical performance, and interaction patterns.*

	Match	Training				
Game characteristics	Mean ± *SD*	Mean ± *SD*	*F*	*p*	η^2	CI
Game duration (min)	45.1 ± 3.1	10.0 ± 0.9	n/a			
Effective playing time (min)	30.5 ± 3.3	8.7 ± 1.1	n/a			
Relative playing time (%)	67.7 ± 6.4	86.9 ± 6.4	60.16	<0.001	0.71	−32.7 to −17.4
BP duration (s)	8.7 ± 1.1	14.0 ± 1.9	69.81	<0.001	0.74	−6.4 to −3.4
Transitions per minute	6.4 ± 1.7	4.4 ± 0.5	20.50	<0.001	0.45	1.7 to 3.2
Team tactical performance						
Inter-team distance (x) (m)	5.4 ± 0.4	5.4 ± 0.8	0.00	1.0	0.00	-0.2 to 2.4
Length (m)	34.8 ± 1.6	33.6 ± 1.9	3.14	0.1	0.07	-0.2 to 2.4
Width (m)	41.6 ± 2.7	43.0 ± 1.9	3.03	0.1	0.07	−3.0 to 0.2
LPW ratio (AU)	0.9 ± 0.1	0.8 ± 0.1	7.31	<0.05	0.15	0.0 to 0.1
Stretch index (x) (m)	10.1 ± 0.4	9.7 ± 0.6	3.22	0.1	0.07	0.0 to 0.1
Stretch index (y) (m)	11.1 ± 0.8	11.3 ± 0.5	0.73	0.4	0.02	-0.2 to 2.4
Surface area (m^2)	1,035.0 ± 104.4	1,011.9 ± 84.2	0.51	0.5	0.01	−3.0 to 0.2
Interaction patterns (%)						
Centroid (x)						
In	88.5 ± 9.8	90.2 ± 3.0	2.89	0.1	0.12	0.4 to 3.8
No	5.0 ± 0.9	5.5 ± 1.2	0.28	0.6	0.01	−1.2 to 0.7
Anti	2.7 ± 0.8	4.3 ± 2.0	4.90	<0.05	0.18	−2.9 to −0.1
Centroid (y)						
In	84.5 ± 9.7	86.9 ± 3.0	1.32	0.3	0.06	−1.0 to 3.5
No	7.3 ± 1.3	7.9 ± 1.1	1.04	0.3	0.05	−1.5 to 0.5
Anti	4.4 ± 1.0	5.2 ± 2.3	1.00	0.3	0.04	−2.3 to −0.8
Length						
In	59.5 ± 6.4	60.8 ± 3.2	0.09	0.8	0.00	−2.3 to 3.1
No	18.7 ± 2.3	19.6 ± 1.6	0.10	0.8	0.00	−1.4 to 1.1
Anti	18.0 ± 3.6	19.6 ± 2.4	0.04	0.9	0.00	−2.4 to 2.0
Width						
In	47.4 ± 7.0	45.0 ± 3.4	5.41	<0.05	0.20	0.5 to 8.4
No	20.2 ± 2.8	20.9 ± 1.2	0.16	0.7	0.01	−1.6 to 1.1
Anti	28.6 ± 5.3	34.1 ± 3.4	5.46	<0.05	0.20	−7.9 to −0.5
LPW ratio						
In	55.8 ± 6.4	59.1 ± 3.7	0.95	0.3	0.04	−4.4 to 1.6
No	20.5 ± 2.7	21.2 ± 1.9	0.01	0.9	0.00	−1.6 to 1.5
Anti	19.9 ± 3.3	19.7 ± 3.0	1.52	0.2	0.06	−1.0 to 3.9
Stretch index (x)						
In	63.8 ± 6.9	64.3 ± 3.5	1.04	0.3	0.05	−1.4 to 4.1
No	16.8 ± 2.3	18.1 ± 1.7	0.53	0.5	0.02	−1.8 to 0.9
Anti	15.5 ± 2.6	17.6 ± 2.6	0.84	0.4	0.04	−2.9 to 1.1
Stretch index (y)						
In	56.4 ± 7.0	53.8 ± 2.9	13.45	<0.05	0.38	2.2 to 7.9
No	17.5 ± 2.3	18.4 ± 1.3	0.20	0.7	0.01	−1.5 to 1.0
Anti	22.3 ± 3.6	27.9 ± 2.7	14.68	<0.001	0.40	−7.3 to 2.2
Surface area						
In	54.0 ± 6.4	52.0 ± 3.7	5.03	<0.05	0.19	0.3 to 7.1
No	18.0 ± 2.6	19.1 ± 1.4	0.87	0.4	0.04	−1.9 to 0.7
Anti	24.1 ± 4.7	28.9 ± 3.6	3.76	0.1	0.15	−6.4 to 0.2

*BP = ball possession; LPW = length-per-width.

Figure 1). For the team tactical performance, only LPW ratio was higher in the match with a large effect size (Table 1). Other inter-team and intra-team distances were similar between the training and match.

Large proportions of in-phase behavior were found for all team tactical variables (Table 1). And, significant higher in-phase relations were found in the match for width, lateral stretch index, and surface area, but other in-phase

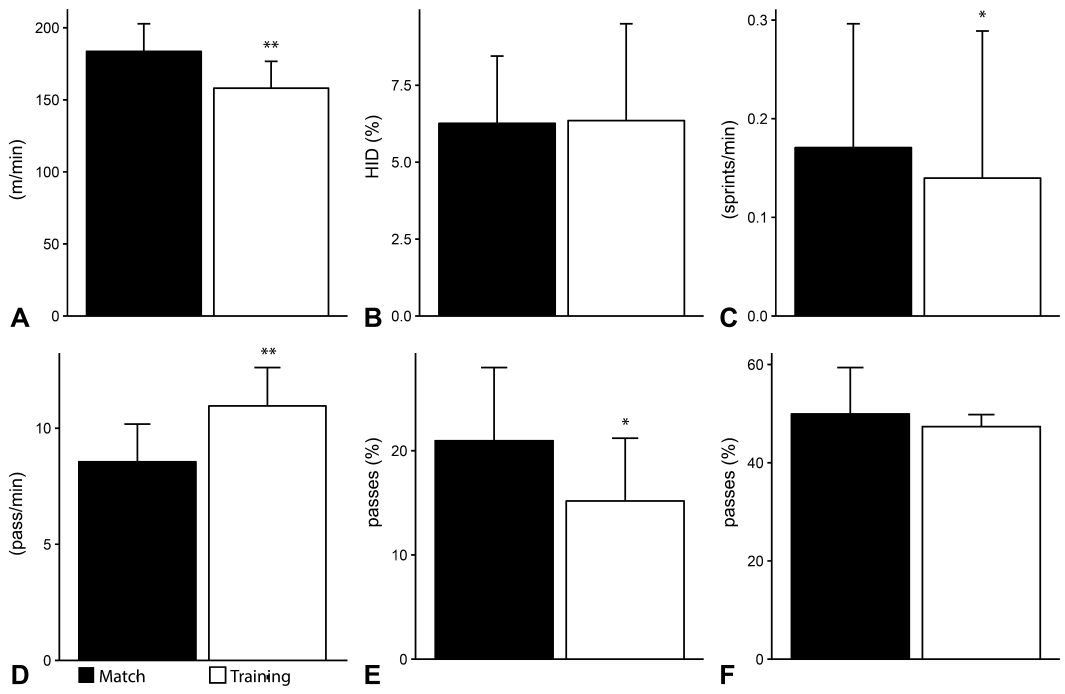

Figure 1. Physical ((A) distance covered; (B) high-intensity distance; (C) sprints) and technical performance measures ((D) game pace; (E) incorrect passes; (F) forward passes) in the official match and training game. Significantly different from the match (*$p < 0.05$ and **$p < 0.001$). HID = high-intensity distance.

patterns did not differ between match and training for other tactical variables. Further analysis of the interaction patterns revealed that there was a significant lower anti-phase behavior in the match for the longitudinal team centroid, width, and lateral stretch index with large effect sizes.

Discussion

The aim of this study was to investigate soccer performance in official matches and 11 vs. 11 training games with an integration of physical, technical, and team tactical performance. In a complex game such as soccer, there is a continuous interplay of physical, technical, and team tactical performance during the game (23). Differences in the constraints in the official match, such as task duration, higher levels of anxiety, expectations of the crowd, and a different purpose (19,28), affected soccer performance compared with a similar format in the training game. In particular, physical and technical performance measures differed between the match and training, and some differences were present in team tactical behavior. In addition, game characteristics were different, displayed by less relative playing time and shorter ball possession duration, but more transitions per minute in the match. It is therefore important to correct performance for this difference in effective playing time and only include performance when the ball was actually in play for an adequate comparison of performance between match and training.

Physical and technical performance, both measures of individual performance, were different in the match compared with the training. Players covered on average more distance and sprinted more often in the match. Also, the technical performance significantly differed in the match: pace of the game was lower, displayed by less passes per minute, and players made more errors in passing. The influence of a different set of constraints on both physical and technical performance can be explained in 2 ways, using the model of Nieuwenhuys and Oudejans (29). A performance decrement is displayed by the ball-carrying players. In the match, they seemed to face difficulties perceiving soccer-relevant information (i.e., pass options from team members), selecting pass options (i.e., knowing whether a team member is a pass option), or executing the pass (i.e., passing with the wrong speed or in the wrong direction). By contrast, the match constraints had a positive outcome on physical performance and on the technical performance of opponent players. Players covered more distance and conducted more sprints. Moreover, players of the opponent intercepted the ball more often. Furthermore, differences in task duration could have contributed to our results. However, contrary to the logical expectation that a shorter training game duration results in higher physical

performance, current results demonstrate a less physically demanding training game. Possibly, players do not give their maximum performance in training like they would do in the match. The bout duration and repetition in this design preserves the ecological validity of a training context and is appropriate for daily soccer practice, instead of 2 × 45 minutes of a match. To sum up, despite a strong expectation of different physical and technical performance as a result of typical match constraints, causality of this behavior is difficult to prove.

Although individual performance differed much between match and training, this seemed less present on team level. During the match, the LPW ratio was larger and approached a value of 1. This implicates that the shape of the teams changed toward a more squared shape in the match instead of a more rectangular shape in the lateral direction in the training. In the match, when it is assumed that something was at stake, the orientation of a team changed toward the goal of the opponent and less in the width of the pitch. Other intra-team measures were not affected in the match and also the inter-team distance did not change. Most of these measures are dependent on the team centroid and, possibly, less sensitive for changes in 11 vs. 11 situations where they do tend to change in small-sided games (5). Where the effect of a different set of constraints was present in individual performance, it may wash out in team performance.

In soccer, there is a continuous interaction between the 2 opposing teams (21). If one team is in possession of the ball and tries to score a goal, the other team tries to prevent this and recover ball possession. High proportions of in-phase behavior in all team tactical measures are an indication that teams moved in the same direction over the pitch and increased and decreased their dispersion in a synchronized manner. This is in accordance with dominant interaction patterns in small-sided games (18,31). Differences in coordination behavior between match and training games were found in the longitudinal team centroids, width, lateral stretch index, and surface area. Longitudinal team centroids moved less in an opposite direction, displayed by a decrease in anti-phase coupling. Higher in-phase couplings were found for the width and lateral stretch index in the match with, consequently, a lower anti-phase coupling. Also, the coupling in surface area showed an increase in in-phase coupling. These are indications of more simultaneous increase and decrease of the dispersion in the match, mostly related to a lateral orientation. Results in this study are in line with findings of Folgado et al. (13), where they found an increase in intra-team synchronization in matches competing against higher-level opponents. They suggested that more synchronization is an indication for increased collaboration within a team to enhance performance. Coordination between teams did change "when something was at stake." Most likely, the match constraints evoked a slightly tighter coupling between teams than the training.

In this study, several personal and environmental constraints were considered to have impact on matches and training games. It was aimed to preserve the ecological validity of match and training as much as possible and this resulted in some practical consequences. Some players were team members during the match, but opponents in the training game. Another consequence was that prematch preparation (e.g., rest day or light training) was not taken into account compared with training. These features add to the personal and environmental constraints in match and training and might have contributed to the differences in performance and can be considered as limitations of this study.

To conclude, soccer performance is a result of an interplay of physical, technical, and team tactical performance, and this performance differed between the official match and training. Differences in constraints as a result of task duration and the consequence of winning or losing, described by anxiety levels, pressure of the crowd, and the purpose of winning instead of developing skills, may account for these differences. Following the natural flow of soccer, an integration of the most important soccer performance indicators is necessary to explain these changes. Starting from a ball-carrier perspective, players made more mistakes on the ball, resulting in more shifts of ball possession between teams. And players covered more distance and sprinted more often. Team dispersion changed toward a more longitudinal orientation and teams were tighter coupled. The latter is an indication that there were fewer opportunities to break movement synchronization patterns. These results confirm intentions of soccer coaches that 11 vs. 11 in training is mainly used to replicate the tactical aspect instead of a physical stimulus, although there were some technical and team tactical differences between an official match and a training game.

Practical Applications

Results of this study confirm the intentions of soccer coaches to use 11 vs. 11 in a practice setting to mimic team tactical behavior of an official match. In this training setting, players perceive and pick up information from their team members, opponents, and the ball in a context similar to the match. So, similar tactical behavior will be trained in 11 vs. 11, despite a different opponent, crowd presence, and different levels of anxiety.

In addition, when coaches would be able to increase the importance of winning and losing in a training game, they would improve representativeness of the 11 vs. 11 training game for the official match. Following the recommendations of Headrick et al. (22), putting emphasis on these constraints will effectively simulate the demands of an official match. Results showed that predominantly physical performance differ between training and match. Most likely, physical intensity will increase as a result of emphasizing the importance of winning in practice, but also technical and team tactical performance and interactions between team will be more representative for the official match. To raise the stake in a training

context, trainers could include playing in front of a crowd, with a referee, or set up an internal competition.

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